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Analysis of electrical audit and energy efficiency in building Hotel BC, North Jakarta

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Abstract. The Hotel BC is using power source from PLN with capacity of 4300 kVA which is divided into 3 units of 2000 kVA transformer. Transformers are used to supply the load of Mall tenants, and Utility loads, such as Chiller, pumps and others. Problems found in the field are complaints from the hotel regarding the safety of electrical installations and wasteful, inefficient electrical costs. The purpose of this study is to check the electrical installation in the building and determine the *Energy Use Intensity (EUI)* and the cost of payment according to usage based on historical data of the building then compare it with the *EUI* standard of Ministry of Energy and Mineral Resources of Indonesia. The method used is survey measurement method and quantitative descriptive analysis by comparing in general condition of energy consumption of this building with standard issued by Ministry of Energy and Mineral Resources of Indonesia. The *EUI* is average 645.58 kWh/m^2/year, or 53.79 kWh/m^2/month, this is inefficient category, because its *EUI* value is > 24 kWh / m^2 / month. For Electrical audit **o**n imaging thermal test at Panel Out Going of chiller pump, 200 ampere, the highest temperature is 97.3^0 C, at 200 ampere phase S termination, and this is included in the major category. The numbers of hot spots on the Capacitor bank panels are 10 major points and Chiller panel has 10 major. There are many major points and they are quite dangerous because they can cause fire hazard on the panel. The AC average temperature and humidity distribution did not meet the standard of SNI (Indonesia National Standard).

Keywords: *Electrical Audit, Energy Efficiency, Energy Use Intensity (EUI)*

1. Introduction

1.1. Profil Discovery Hotel Ancol

BC Hotel is a hotel located in the heart of North Jakarta's tourist attractions which provides a comfortable base for families, friends, and colleagues, with modern interpretations of contemporary stylish design and elegant neutral tones. This building is over 20 years old and located in Pademangan, North Jakarta. Building Hotel BC consists of a main building 10 Floors, on floor 3 to 8 is used for hotel guest rooms and on other floors are used for main lobby, ballroom, and other public facilities.

Safety, convenience, and efficiency are the most important factors for achieving customer satisfaction and operational productivity. Therefore, an awareness of the importance of maintenance and security of the building, especially in the danger of electric fires. A study showed 60% of fire incident due to an electrical short circuit, so it needs early detection and preventive maintenance to prevent the occurrence of an electric fire hazard. During this time, usually the owner is more focused on the core business and less concerned about the condition of the district, whereas the company must protect the assets and must be safe against fire hazard. Electrical hazards cannot be detected by the invisible and

the layman and the limitations of instrumentation and labor tools. The company also wants a saving (efficiency) on the building considering the building is more than 20 years old. The aged building is often found to increase electricity bills over time, thus increasing maintenance costs.
One of the ways to check and monitor energy consumption is to audit the energy, so that energy consumption data can be seen from a particular process or machine and can be seen inefficient energy consumption. The parameters used are energy consumption intensity (IKE) in buildings defined in energy quantities per unit area in buildings served by energy (kWh / m2 / year or kWh / m2 / month). Meanwhile, to check the electrical safety of electrical audit required by using a thermographic tool.

1.2. Profil Discovery Hotel Ancol
BC Hotel is a hotel located in the heart of North Jakarta's tourist attractions which provides a comfortable base for families, friends, and colleagues, with modern interpretations of contemporary stylish design and elegant neutral tones. This building is over 20 years old and located in Pademangan, North Jakarta. Building Hotel BC consists of a main building 10 Floors, on floor 3 to 8 is used for hotel guest rooms and on other floors are used for main lobby, ballroom, and other public facilities.

1.3. Objective of this Project
1.3.1 To know the value of Energy Use Intensity (EUI) at Hotel BC
1.3.2 To find out if all Electrical installations and equipment are in good condition, safe and in compliance with applicable standards and regulations.

1.4. Problem Formulation
Hotel BC is a hotel that is more than 20 years old so it needs to be done step austerity and efficiency and replacement of electrical or mechanical equipment. Buildings that are more than 20 years old usually have complaints of increased energy consumption over time, so the bill is more wasteful than the new building. Some machine tools such as air conditioners, pumps have decreased performance because they are old and need to be checked again. Furthermore, some electrical equipment and cables have decreased quality and peeling so that must be wary and replaced to prevent the occurrence of fire. To manage the power and security needs of buildings, it is necessary to save energy and electrical security checks on the building.

2. Methodology Adopted
The methodology adopted for this research is:
2.1 Method of Collecting Data
Data collection is done by survey method, recording monthly report data, and measurement in an electrical panel. This research uses primary data type and secondary data. Tools used Thermografik, Tang Ampere, and Multimeter, and Cos phi meter.

2.2 Method of Analyzing Data
Data were collected and then analyzed by using quantitative descriptive analysis. The research variables include the amount of energy use based on energy audit and saving opportunities based on field conditions. In the initial of energy audit, will be calculated the amount of Energy Consumption Intensity (IKE) per unit area is conditioned (net area) according to usage based on campus historical data. In a detailed energy audit will be calculated IKE based on observations of the use of electrical energy in detail with various equipment that consume electrical energy and the time of its use. Furthermore, for electrical audit, an infrared thermographic tool used in various of panels. The data will then be analyzed the percentage of major and minor amounts, then which parts should be repaired or replaced, thus preventing risk of any fire hazard. To find the value of IUE then the formula used is :

$$IEU = \frac{The\ amount\ of\ KWH\ per\ m\ square}{building\ area} \quad (1)$$

The IEU standard values for each building are as follows :

Table 1. Value of energy consumption intensity standards in building, based on activities (Reference ASEAN USAID 1987)

No	Type of Building	EUI (Kwh/m2/year)
1	Office	240
2	Mall	330
3	Hotel	300
4	Hospital	380

If (EUI) > 240 kwh/m2/year for office building, it means Energy consumption not efficient

3. Result and Discussion

3.1 The Value of Energy Use Intensity (EUI) at Hotel BC

The energy use intensity (EUI) in the building is the value of the indicator to measure the level of energy efficiency in a building. Unit Intensity of energy consumption in the building is the amount of energy per unit area in buildings served by energy (kWh / m2 / year or kWh / m2 / month). Total Kilowatt per hour / month in Hotel BC, Jakarta could see in Figure 1.

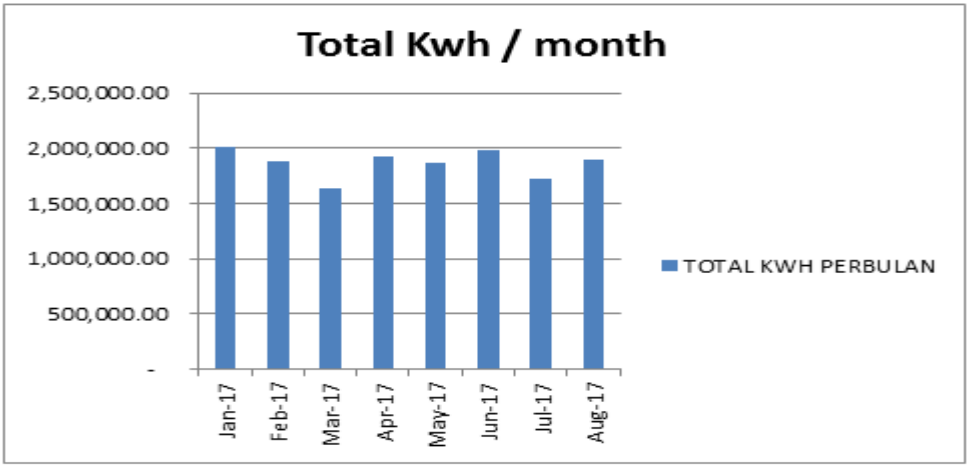


Figure 1. Total Kilowatt per hour / month in Hotel BC, Jakarta.

Then below is a graph of total cost of electricity usage BC Hotel per month.

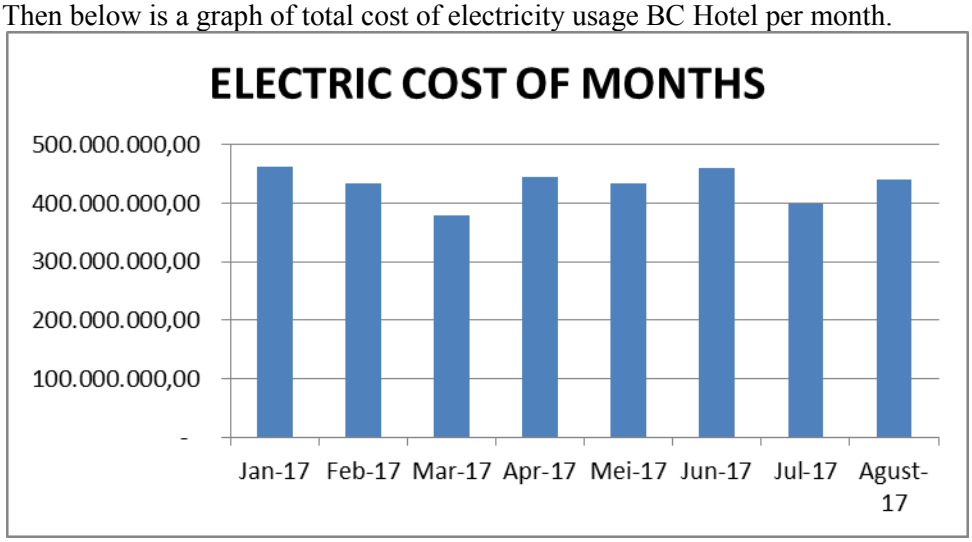


Figure 2. Total electric cost per month in Hotel BC, Jakarta.

As we know that the building area of the hotel bc is 34,616 m2, and the evarage kwh per month is 1,862,285. So the EUI value is 53.79 kWh/m^2/month or 645.58 kWh/m^2/year. As we know that the building area of the hotel bc is 34,616 m2, and the evarage kwh per month is 1,862,285. So the EUI value is 53.79 kWh/m^2/month or 645.58 kWh/m^2/year. The electrical load distribution at BC Hotel Building, the highest is air conditioning, then followed by lighting. The full percentage is as follows:

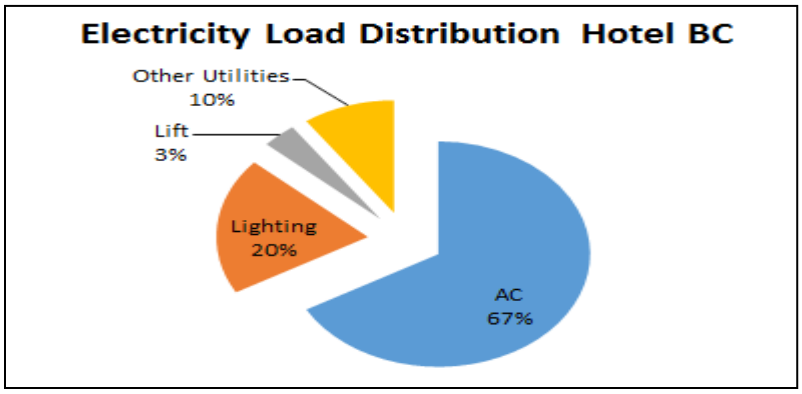


Figure 3. Estimated electrical load distribution at Hotel BC, Jakarta

From Table 1 it can be compared between the actual value of EUI in the field with reference value of ASEAN USAID standard 1987. Based on this table the value of EUI Building Hotel BC = 645.58 kwh/m2/year, included in the category inefficient / wasteful.

The potential for energy savings can be focused on the system of air and lighting in the BC Hotel Building. Use of R-410 or R-32 refrigerant on AC inverter to replace R-22 refrigerant on some Split AC units to be installed. Because the freon type R-410 or R-32 is lighter than the freon type R-22 so that the compressor work is not too heavy and electric energy is also smaller, besides that this type of freon has entered standard green because it does not damage ozone. The Simulation for Energy Saving Potential (PHE) is as follows:

Table 2. Simulation for energy saving potential

No	Description	Watt/1 PK	Energy Consumption /th	Cost (Rp)	Calculation
1	74 AC, 136,5 PK	864	118 kWatt	-	354,000 kwh / year
2	74 AC, new, using AC inverter, 136,5 PK (a)	540	73.71 kWatt	477,750,000 (a)	221,130 kwh / year
3	Potential Savings	324		179,640,240	132,870 kwh / year
4	Payback Period (a/b)				2.66 years

Description : 1 year = 3,000 hours, 1 month 25 days, 1 day 10 hours, 1 Kwh = Rp. 1,352 price AC 1 PK inverter Rp. 3,300,000

From the simulation for Energy Saving Potential (PHE) based on the above table is that by replacing the old AC into AC inverter with the latest technology then the cost incurred is Rp. 477.750.000 with the potential savings of Rp. 179,640,240 per year or with pay back perode is 2.66 years

The above analysis shows that the EUI value for BC hotels is 696 kwh / m2 / year which means greater than the standard value of 300 kwh / m2 / year, and this means very wasteful. Therefore it is necessary to do the energy saving step as follows:

1. Fix the Building Automation System (BAS) system to set the central AC system.
2. If possible, increase the AC temperature setting.
3. Perform AC maintenance (filter cleaning at least 3 months).
4. Turn off the AC and lights if the room is not in use.
5. Replace electrical appliances, air conditioners, and pumps that exceed the technical age limit (more than 20 years).
6. Control-motor control should use Variable Speed Drive(VSD).
7. The transformer capacity can be lowered to 1000 kVA to reduce transformer losses. Currently, the transformer load is only 28.3%.

3.2 The Electrical Audit at Hotel BC

Hotel BC uses a power source from PLN with a capacity of 1,730 kVA, with one unit of 2000 kVA transformer. Hotel BC à in the back up of 2 units of Generators with a capacity of each 1000 kVA parallel synchronous before supplying power to the loads. Maximum usage load à453 kW or 566 kVA, 33% of total power connection of PLN. This thermal data collection is obtained during measurement using the Thermography Infra Red tool. Category results description is Major for temperature 70^{o}C or more, Minor for 65-69^{o}C, Observation for 50-64^{o}C, and Normal for 30 - 49^{o}C. Here are the results of thermographic measurements on some electrical panels :

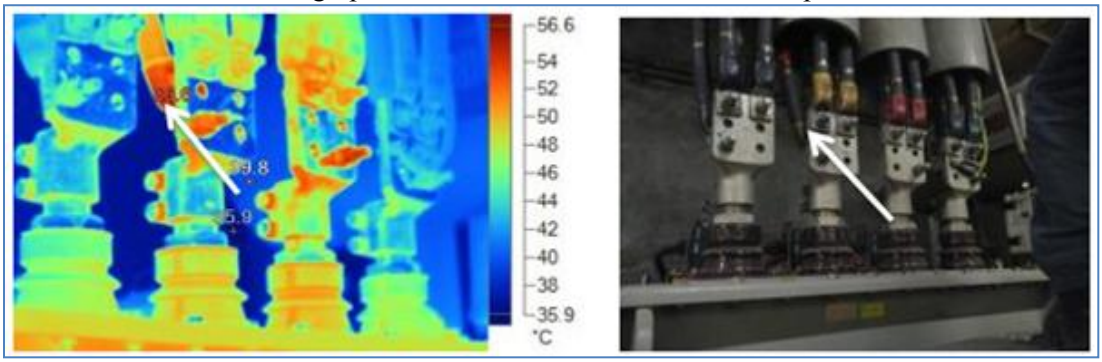


Figure 4. Thermographic test data on 2000 kVA transformer, with load 566 kVA

The result of thermal imaging at 2000 kVA transformer, Out Going Cable Spot, obtained result of the highest temperature 56.6 ° C. The highest temperature is found in phase S cable skeleton, with load at each phase is R = 929.9 A, S = 907,3 A , T = 853.9 A. The temperature in this panel is still in the normal category, no need for improvement.

Next is the results of thermographic measurements on some electrical panels at Panel Out Going of chiller pump, 200 A.

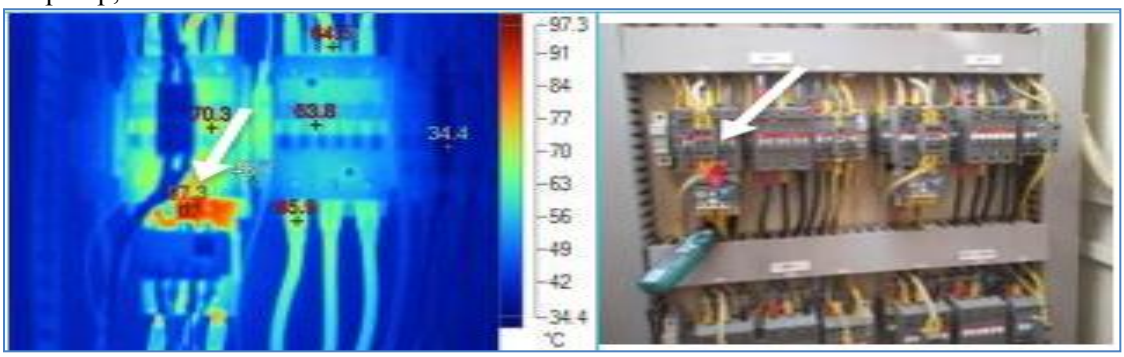
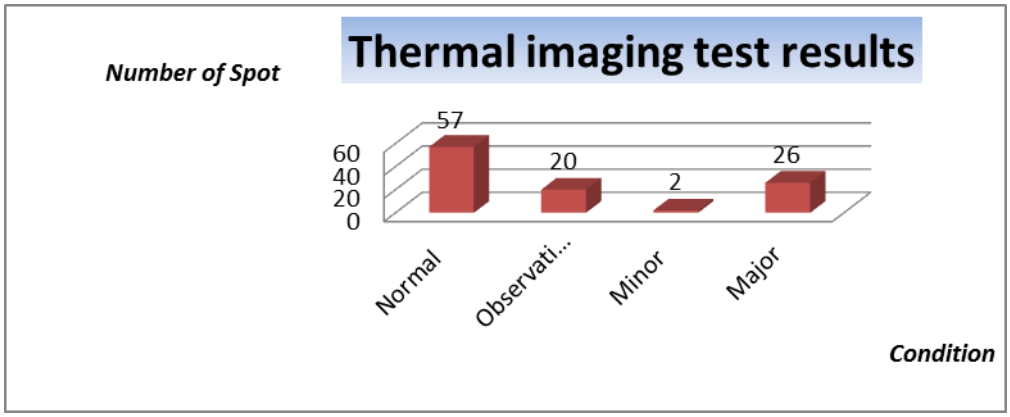


Figure 5. Thermo graphic test data at panel out going of chiller pump, 200 A

At Figure 4 there is Thermo graphic test data at Panel Out Going of chiller pump, 200 A. That Panel Out Going for chiller pumps on 200 200 C Contractor Slot, the highest temperature is 97.3 C, at 200 A phase S termination, while the load has reached 93.1 A and the temperature of the contactor body is 70.3 C, with cable using NYAF type 16mm. With the highest Temperature of 97.3 C, this is included in the major category. The panel on the cable uses NYAF type 16 mm, does not match the load. We recommend wiring NYAF 16 mm replaced with NYAF 35 mm cable. Further recapitulation of all electrical panel at Building Hotel BC is as follows:



Description : Major = > 70°C, Minor = 65-69°C, Observation = 50-64°C, Normal 30 – 49°C.
Figure 6. The thermal imaging test result

Further details about panels that have major and minor hot spots are as follows:

Table 3. Number of major and minor hot spots on the building panel

No	Panel Name	Major	Minor
1	Capacitor Bank Panel	10	-
2	Chiller Panel	10	1
3	AHU Panel	1	1
4	Pump Panel 11th Floor	2	-
5	Tenant 12nd Floor	1	-
6	Panel 7th Floor	1	-
7	STP Panel	1	2
	Total	26	2

From the table above shows that total of the major categories are 26 spots, while minor are 2 spots. The number of hot spots on the capacitor bank panel there are 10 major points, and chiller panel has 10 major and 1 minor point. In addition, there are panel AHU panel, tenant panel, panel floor 7 and STP panel which also has 1 major point each, while the pump panel there are 2 major panels. The number of major points is quite dangerous because it can cause excessive heat can eventually occur short-circuit or fire hazard on the panel. It is imperative to take precautionary measures, for example by cleaning the panel, replacing the cables or tighten the termination of the contactor.

The type of air conditioner used in Hotel BC is a type of central air conditioner and partly split AC. Here is the measurement of the use of air conditioning in each room in Hotel BC.

Table 4. Humidity and air temperature, in the room of Hotel BC

No. Room	Room	Temp (^{0}C)	RH (%)	dB	
				Low	High
606	FCU-6-606	22.90	62.90	37.90	42.80
615	FCU-6-615	26.90	65.50	39.70	42.10
625	FCU 6-625	24.70	67.20	37.50	42.10
626	Living Room	24.90	65.30	38.80	45.40
215	Bedroom	24.60	59.70	44.10	44.20
628	Ruang Tamu	22.80	63.50	37.10	39.30
216	Bedroom	23.30	59.70	41.30	46.80
415	Bedroom	23.40	59.70	44.90	47.60
550	Living room	24.10	63.00	38.70	43.40
313	Bedroom	23.10	59.50	37.50	44.10
314	Bedroom	22.70	68.20	37.00	40.20
604	Living room	23.10	63.40	44.80	48.80
Avg		**23.88**	**63.47**	**39.94**	**43.90**

In Table 4 above shows that Hotel BC has an average temperature average 23.88 ° C. The distribution of temperature is approaching SNI standard (24 °C - 27° C) of total measured space. For humidity (RH) lowest value measured 59.5% and highest humidity 67.2%. It was concluded that the distribution of humidity distribution did not meet the standard of SNI (Indonesia national standard) 55% - 65%.

4. Conclusion

EUI is expressed as energy per square foot per year. It's calculated by dividing the total energy consumed by the building in one year or the month by the total gross floor area of the building. The IEU of the building 645.58 kWh/m^2/year, or 53.79 kWh/m^2/month. The analysis shows that the EUI value for BC hotels is 645.58 kwh / m2 / year which means greater than the standard value of 300 kwh / m2 / year, and this means very wasteful. Therefore it is necessary to do the energy saving step as follows : Fix the Building Automation System (BAS) system to set the central AC system. If possible, increase the AC temperature setting, Perform AC maintenance (filter cleaning at least 3 months), Turn off the AC and lights if the room is not in use, and replace electrical appliances, air conditioners, and pumps that exceed the technical age limit (more than 20 years). Distribution of temperature is close to SNI standard (24 ° C - 27 ° C) of total measured space. It is not the standard of SNI (Relative humidity (RH) lowest value measured 59.5% and highest humidity 67.2%. It was concluded that the distribution of humidity distribution did not meet the standard of SNI (55% - 65%).

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